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MARMALADE JUICE AND JELLY JUICE FROM CITRUS FRUITS

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The profitable use of cull oranges and lemons has become a problem of growing importance to the citrus industry because of the rapid increase in production in recent years. If the market for the fresh fruit is to be extended, it is necessary that the marketing of cull fruit in competition with graded fruit be prevented and that the present high standard of quality of the latter be maintained.

California normally produces more than 60,000 carloads of fresh citrus fruits annually for the market. Estimates of the amount of cull fruit vary greatly, but it represents probably at least 5 per cent of the total production, or not less than 45,000 tons. Some of this cull fruit is at present utilized in the preparation of citric acid, marmalade, orange vinegar, dried peel, citrus juice, etc., but a very large proportion is discarded or sold in local markets in competition with the graded fruit. In years when frost injury is serious, the proportion of cull fruit is greatly increased.

The writers believe that the manufacture of two products, which we have called "canned marmalade juice" and "jelly juice," would afford a profitable outlet for a large quantity of orange culls. These products are suitable for household use and for the commercial preparation of marmalade and jelly. They would save the housewife and the marmalade manufacturer the expense and trouble of preparing the fresh fruit and would insure more uniformly successful results. Our investigations show that they can be prepared at a cost sufficiently low to be marketed at a price within the reach of the average consumer. Marmalade or citrus jelly made from the canned juice is much cheaper than similar products purchased in the finished state or prepared in the household from fresh fruit purchased from fruit stores.

Citrus jelly juice, as described in this publication, is prepared by boiling sliced oranges, lemons, or grapefruit, or a mixture of any two or all of these fruits, with water, and then expressing, clarifying, canning or bottling, and sterilizing the liquid so obtained. It is rich

in pectin and acid, the constituents of fruits necessary for jelly making. It is light amber in color, slightly cloudy, and possesses the characteristic flavor of the cooked fruit. When concentrated by boiling with the proper proportion of sugar to the jelling point it yields a clear, firm jelly of light amber color and pleasing flavor.

Citrus marmalade juice is citrus jelly juice to which has been added from 10 to 20 per cent of boiled, sliced peel.

These products may be prepared and canned in fruit canneries or in marmalade factories.

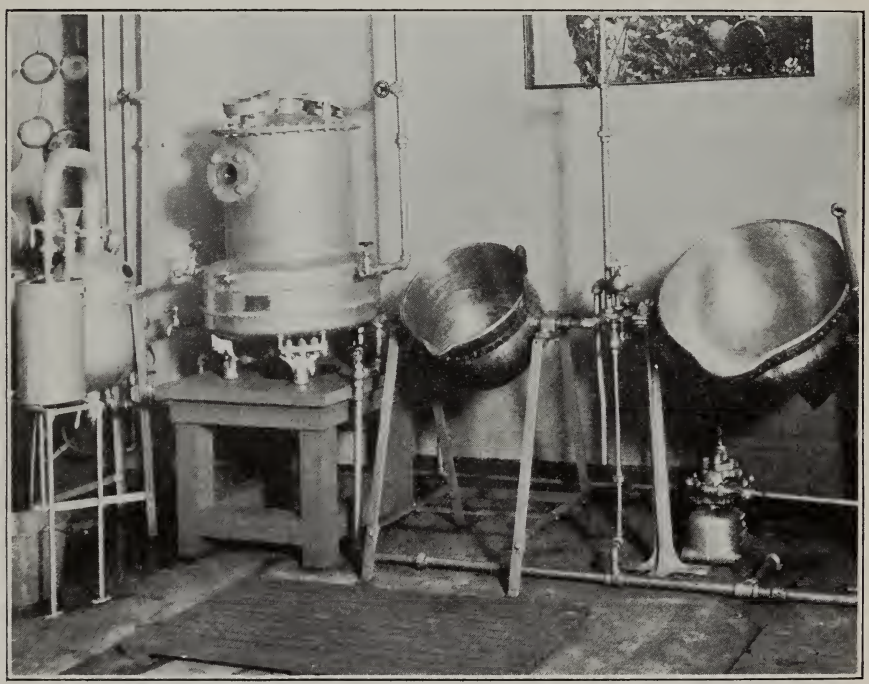

Fig. 1.—Steam-jacketed jelly kettles and vacuum pans used in the Fruit Products Laboratory for heating cut fruit and for concentrating juice.

RESULTS OF INVESTIGATIONS

Experiments upon the manufacture of marmalade juice were first made at the University in 1915. The results were successful, although no attempt was made at that time to investigate the details of the process. During the past six months one of the writers has given most of his time to a careful study of the factors involved in making citrus jellies, marmalades, and the canned juices and has developed a method of preparing the canned juices which, it is believed, can be applied upon a commercial scale.

The method recommended in this publication is based upon the results of these investigations. They will be reported fully in a later publication. A brief statement of the results of the experiments having a direct bearing on the subject of this circular is given herewith.

1. Unripe oranges yielded a bitter juice, as did much of the fruit gathered at the beginning of the season, even when complying with the 8:1 standard.

2. It was found better to cut the fruit into pieces about one-eighth of an inch thick, rather than one-quarter or one-half of an inch thick, for boiling and extracting the juice.

3. Boiling in two lots of water in successive periods of 45 minutes each gave the best results with respect to yield and clarification.

4. Pressing the boiled fruit gave a much higher yield than straining through cloth without pressure.

5. The most effective means of clearing the juice was found to be by settling and racking (drawing off the clear juice). Filtration through felt bags or wood pulp gave fairly satisfactory results.

6. Long boiling of the fruit or juice in copper resulted in darkening the color; boiling in aluminum and glass-lined equipment did not darken the color.

7. The most satisfactory method of preparing sliced peel for marmalade juice was found to be the following: Cut off small portions at the blossom and stem ends of the fruit. Remove the remainder of the peel in quarters. Cut this lengthwise in very thin slices (about $\frac{1}{16}$ to $\frac{1}{32}$ of an inch thick).

8. Lemons yielded a better jelly juice than a mixture of oranges and lemons. A mixture of equal weights of lemons and oranges, however, was almost as good and gave a product much superior in flavor, color, and general appearance to that made from the usual mixture of 10 per cent and 90 per cent, by weight, of lemons and oranges, respectively. Oranges in this large proportion darkened the color of the juice and imparted a "stale" or "medicinal" flavor. Ten per cent, by weight, of grapefruit added to a mixture of equal weight of lemons and oranges gave a juice of pleasing bitterness.

9. It was found that the juice should contain at least 1 per cent of pectin and a similar amount of acid.

10. Marmalade juice canned in December, 1919, at the present writing (February, 1922), still retains its jelling power and the other desirable qualities.

11. Juice was found to retain its color and flavor better in lacquered cans than in plain tin cans.

PREPARATION OF MARMALADE JUICE

1. *Proportion of oranges and lemons.*—Use equal weights of oranges and lemons. If a bitter juice is desired add 10 per cent, by weight, of grape fruit.

2. *Extracting the juice.*—Slice the mixed oranges and lemons about ⅛ of an inch thick or crush in an apple grater. Add twice their volume of water. Boil 45 minutes. Separate the juice by press-

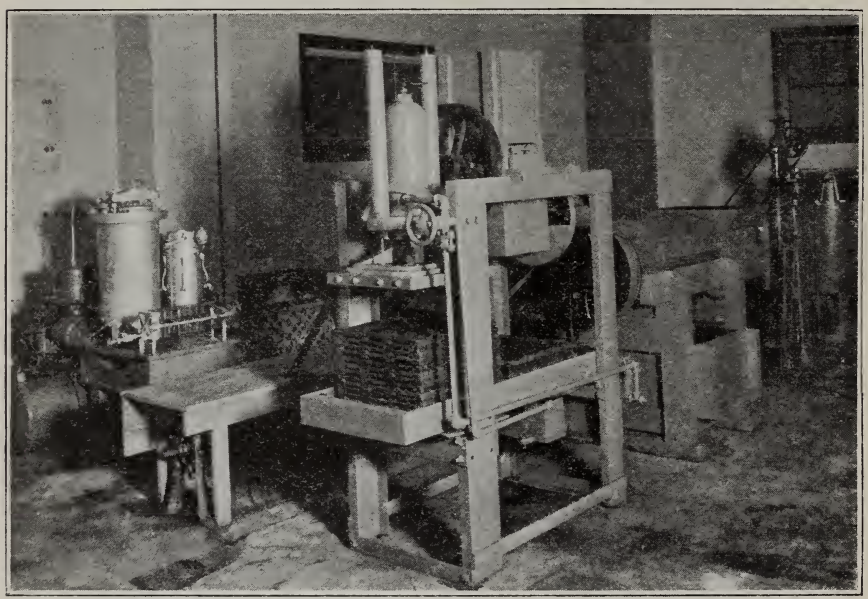

Fig. 2.—In foreground, press used in Fruit Products Laboratory for extraction of juice. In background, can sealer. At left, pressure filters and vacuum pump.

ing or draining through cheesecloth. Add enough water to cover the pulp and boil again for 45 minutes. Press again and combine the juice from the two lots and strain through cloth.

3. *Clearing the juice.*—Set the juice aside overnight in 5-gallon bottles or in a tank that will not be affected by the juice. Pour or siphon off the juice from the sediment and strain through a felt jelly bag. The juice may also be clarified by means of a high-speed centrifuge or by filtration through wood pulp or a filter press.

4. *Concentration of the juice.*—Boil the juice down rapidly until it is rich enough in pectin to form a good jelly. If the juice is to be canned commercially, it is suggested that it be concentrated from 10° to 12° Balling, cold test, equivalent to about 1¼° to 3¼° Balling,

test made on boiling hot juice. Juice of this concentration will make good marmalade or jelly when one cup of the juice is mixed with 1¾ to 2 cups of sugar and boiled one or two minutes. If concentrated to 5° or 6° Balling, only one cup of sugar need be used with each cup of juice. In this case the mixture must be concentrated by boiling to 220° or 221° F. Strain the hot juice through filter bags or clarify by centrifuging.

5. *Preparation of peels.*—Remove the peel in quarters from large oranges after first cutting off small portions from the blossom and stem ends. Slice the peel lengthwise very thin, if possible to $\frac{1}{32}$ of an inch. Peels may also be prepared by removing a broad band about ¾ of an inch to one inch wide around the greatest circumference of the fruit and cutting these ribbons of peel in very thin shreds about ¾ inch to one inch long. Boil the peels until tender, then discard the water. Allow to drain on a screen.

6. *Addition of peel to juice.*—To cold juice (60°–64° F.) testing 10°–12° Balling, add about twenty parts, by weight, of shredded peel to 100 parts by weight of juice, or 1½ pounds of peel, per one gallon of juice. To juice testing 6° Balling cold, add ¾ of a pound of peel per gallon of juice.

7. *Testing.*—Prepare one or more glasses of marmalade from each lot to make certain that the product will jell. If the juice is of 10° to 12° or more Balling (cold test), the product should make jelly when 1¾ or 2 cups of sugar are added to one cup of juice and the mixture is boiled about two minutes. If the juice is of about 6° Balling (cold test), add one cup of sugar to one cup of juice and boil to 221° F., or until the boiling marmalade will hang in sheets from a cooking spoon. If the test shows the juice to be deficient in pectin, concentrate it to such a Balling degree that good jelly can be prepared from it without difficulty.

8. *Canning and sterilizing.*—Heat the mixture of peels and juice to boiling without adding sugar and place in jars or lacquered cans while boiling hot. Fill cans completely. Seal immediately and invert to cool.

9. *Recipe for use.*—The label should carry a suitable and simple recipe for the use of the contents of the can. For juice of 10°–12° Balling prepared as above this may be: "To each cup of this juice and peel add from 1¾ to 2 level cups of sugar. Boil about two minutes. Skim and pour into glasses."

If the liquid is of only 6° Balling, the recipe may read: "To each cup of juice and peel, add one level cup of sugar. Boil until a thermometer inserted in the boiling juice reads 221° F., or until the liquid will hang in sheets (jell) when allowed to fall from a spoon."

The writers prefer the juice of higher concentration (10° Balling) because its use requires no previous experience on the part of the user.

A good dairy thermometer is convenient for taking the temperature of the juice. A Balling hydrometer of good quality and reading to $\frac{1}{10}$°

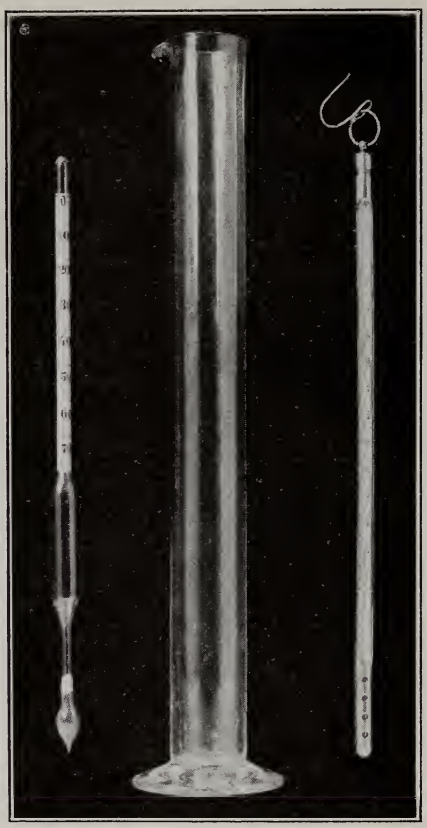

Fig. 3.—Balling hydrometer, hydrometer cylinder, and thermometer.

should be employed. A copper hydrometer cylinder about 1½ inches wide and 15 to 18 inches deep is very convenient for holding samples of juice.

EFFECT OF TEMPERATURE ON BALLING TEST

Balling hydrometers are standardized for use at 60° F. In the process of preparation of the jelly juice, the test must be made upon the hot liquid, usually at 180–200° F. Since a rise in temperature causes liquids to expand, the Balling hydrometer will give readings that are too low. Data from tables which give the effect of temperature

upon the Balling test have been arranged in such manner that the Balling degrees in the table are those of a juice of 10° Balling (60° F.) heated to the temperatures shown in the table.

Thus, if the juice is tested at 190° F. it must be concentrated until the Balling hydrometer will indicate at this temperature 2.2°–4.1° Balling if a juice of 10°–12° Balling is desired; or if the test is made at 150° F., the instrument must show 5.5°–7.5° Balling, and similarly for other temperatures.

TABLE 1

EFFECT OF TEMPERATURE ON THE READING OF A BALLING HYDROMETER

Temperature of juice Deg. F.	Balling degree of juice equivalent to 10 deg. Balling cold test	Temperature of juice Deg. F.	Balling degree of juice equivalent to 10 deg. Balling cold test
60	10.00	130	6.9
68	9.90	140	6.2
75	9.60	150	5.5
90	9.00	160	4.7
100	8.50	170	3.9
110	8.00	180	3.1
		190	2.2
120	7.50	200	1.2

PREPARATION OF JELLY JUICE

Use equal amounts of thinly sliced oranges and lemons and proceed as directed above for the preparation of marmalade juice, but omit steps 5 and 6. This product is canned without the addition of peel.

SUMMARY

1. The uncertainty and most of the labor of making citrus fruit jelly and marmalade in the home can be eliminated by the use of concentrated canned citrus jelly juice and marmalade juice. These juices can be prepared in canneries in the citrus growing districts, by methods described above, and distributed through the usual trade channels. The cost to the housewife of juice and sugar to make a 6-ounce glass of marmalade or jelly will not exceed five cents. The canned juices are also suitable for use in the preparation of marmalade and jelly upon a commercial scale.

2. The jelly juice is prepared by boiling sliced oranges and lemons (equal weight of each) with water and pressing, followed by straining, settling, drawing off the juice from the sediment, filtering, and

concentrating by boiling. The juice is filled boiling hot into lacquered cans and sealed at once. Marmalade juice is prepared in the same manner, except that thinly cut boiled peel is added at the time of canning.

3. A higher yield of pectin is obtained by the use of fruit cut to ⅛ of an inch in thickness or less than from that cut ¼ of an inch or thicker.

4. Boiling for an hour and a half is necessary to obtain a maximum yield of pectin. The juice is more easily cleared and the yield of pectin is increased if the fruit is boiled and leached with two lots of water for 45 minutes in each case (a total of 1½ hours).

5. The juice should contain at least 1 per cent of acid and pectin, respectively.

6. The writers believe that canned marmalade juice and to a less degree canned citrus jelly juice possess sufficient merit to make their commercial production worthy of serious consideration by canners and manufacturers of citrus by-products. Their production should afford a profitable means of utilizing fruit-canning equipment during the winter and spring months.